JPRS L/9954

1 September 1981

Worldwide Report

TELECOMMUNICATIONS POLICY, RESEARCH AND DEVELOPMENT

(FOUO 12/81)

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CONTENTS

JAPAN

CAPTAIN DATA SEARCH SERVICE TO HAVE SECOND TEST PERIOD

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 8 Jul 81 p 4

[Text] The Ministry of Posts and Telecommunications has begun studying the implementation of a service using the CAPTAIN system (character and patterns telephone access information network), scheduled to be ready for use in 1983, with outside on-line systems. It could be used for such purposes as checking bank account balances and making airline and train reservations. The CAPTAIN system is a data search service in which graphic data is called up on a video screen from a data base in a location separated from the user. However, the Ministry of Posts and Telecommunications has decided that this function alone is too limited and not conducive to wide dissemination. Therefore, it is attempting to expand the functions of the system.

The Ministry of Posts and Telecommunications and the Nippon Telegraph and Telephone Public Corporation are taking the lead in preparing for the application of the CAPTAIN system. The first test period was from the end of last year to March this year, and the second test period is scheduled to begin this August. During the first test period, information was only displayed on a video screen. During the second test period, the users terminal equipment will be operated so as to provide better service.

The following kinds of new service will be added: 1) the sending of buying orders in response to shopping information, 2) the use of a copy function to keep a record of the information on the screen, and 3) the organization of a "closed user group," which will be able to call up special information on the screen.

At present, only the information entered in the CAPTAIN system's data base center can be called up. With the second test period, it will become possible for the provider of the information to revise the data entered in the data base. However, direct access from the user's terminal to the data base of the information provider will not yet be possible.

For this, the Ministry of Posts and Telecommunications is planning to connect the CAPTAIN system with certain on-line networks to provide a service with direct access from the terminal to the on-line network. For example, with the present system, if the user wants to know his bank account balance, he cannot get the information unless it has already been entered into the CAPTAIN system center. This is not very practical.

If it becomes possible to have direct access from the CAPTAIN terminal to the bank's on-line network, the step of putting the information from the bank into the center can be eliminated and the user can find out his balance immediately.

Also Under Development in the United States and Europe

With the CAPTAIN system, the user can select the necessary information such as news, recreation information, shopping information, etc, and have it displayed on a screen at any time. It is a two-way service since the user can select the information. CAPTAIN is the name of the Japanese system but a similar system, commonly called Videotex, is under development and partially being applied in the United States and Europe.

The Ministry of Posts and Telecommunications surveyed the experiments with Videotex started in June of last year in Berlin and Dusseldorf. They found that, in addition to data search from the user's terminal similar to the CAPTAIN system, a number of services were available through connection with an external computer data base. These include making reservations, sending shopping orders, and data processing with an ordinary language system. There are already 11 of these external data bases in service, and the number is expected to grow to 35 soon.

In Great Britain, where practical use of Videotex was first undertaken, the West German system has been adopted. Preparations are underway to hook up with an external computer beginning next year. Canada and France are also conducting experiments in order to achieve the same type of sophisticated service. The key to gaining wide acceptance for the CAPTAIN system is to provide this kind of high-quality service through connection with an external computer, and the Ministry of Posts and Telecommunications has begun studying the matter.

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CSO: 8129/1522

USSR

UDC 621.395.74.397.12

TELECOMMUNICATION IN THE POSTAL SERVICE DISCUSSED

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 81 pp 12-16

[Article by Y. Ye. Bukhviner: "Telecommunication in the Postal Service." Submitted 22 Jul 80. Published as a matter for discussion]

[Text] The postal service in the USSR handles as many as ten billion messages annually most of which are delivered by mailmen. One half of the communication workers of the country are postal workers and their work is not very effective. A substantial increase in their labor productivity can be achieved by reducing the volume of sorting and transportation of mail through the introduction of telecommunication methods in the postal service, i.e., by transmitting simplex written messages via channels of telephone networks during the low-load hours.

As the telephone networks develop, there also arises the problem of the optimization of the transmission of simplex speech and machine messages whose amount is steadily increasing. Therefore, communications administrations of many countries are searching for a systemic solution of the problems of utilizing the reserves of telephone networks. Among other things, automated systems are being developed for transmitting postal correspondence by telecommunication facilities which are referred to as "electropost", "electronic post office", "electronic message transmission service", etc.

Studies in the area of electronic postal service are being conducted by the World Postal Union and International Telecommunication Union. Now, it is necessary to search for the most rational ways of using the above possibilities in application to the nationwide communication network of the Soviet Union.

The editors are inviting specialists to participate in the discussion of the problems treated in this article.

Organizational Principles of the Electronic Postal Service. The present state of electronic engineering, public telephone networks and the self-service system for clients makes it possible to reproduce texts without their repeated (as in telegraphy) manual typesetting. The electronic postal service is a system for transmitting simplex messages through communication channels under the control of a central computer which collects, processes, stores and delivers signals during the hours when the networks are underloaded [1].

The increasing shortage of labor resources and needs of the clients in better postal services, in addition to the presence of reserves in the traffic capacity in telecommunication networks, have become objective reasons for the introduction of the electronic postal service.

The reserves of GTS [city telephone exchanges] can be used for transmitting postal correspondence at night and the reserves of intercity networks can be used for transmitting written messages from the periphery to the center, which is very important in collecting report data. Postal services delivering printed matter, parcels, and a number of other types of mail cannot be replaced by telecommunication facilities. Consequently, it is necessary to isolate those communication services which can be economically effectively realized in the public telecommunication network. Electronic postal service ensures the transmission of urgent correspondence both for the subscribers of telephone networks (primarily to organizations and enterprises) and to clients of the postal service.

Various services which are included today in the concept of the electronic post office provide a complex of communication services determined by the possibilities of the message processing centers and the terminal equipment [2,3]. Variations of loads during the twenty four hour period are apparent the most at GTS, therefore, it is in cities that the electronic postal service is effective the most. Specifically, it speeds up business correspondence and unloads the telephone network and subscribers' teletypewriters from the transmission of a part of simplex messages. (See Table 1)

A facsimile set with open recording which automatically transmits and receives documentary information in communication departments [2,3] is the most promising terminal of the electronic post office. As is known, it makes it possible to transmit in a standard TCh [tone-frequency] channel textual (printed or written in any language) messages which have the validity of a legal document, as well as drawings, charts, and other images. Facsimile signals can be relayed in the analog or digital form, similarly to speech signals, at a rate of not less than one document of A4-sheet in size in six minutes.

Foreign systems of electronic post office services use chiefly photograms today for transmitting written messages, although there is also a pressing need of transmitting oral simplex messages -- phonograms, as well as computer messages -- machinograms (Table 2). These three types of messages which are equivalent to written messages, are conventionally called mailograms [2].

All types of messages shown in Table 2 can be transmitted by telecommunication signals in the course of one minute and satisfy the needs of business and private communications. Consequently, there arises the possibility of creating a complex system of simplex transmission of oral and written messages. Simplex transmission of speech and facsimile signals to communication departments or to the subscriber will make it possible to deliver messages to the addressees efficiently in the course of twenty four hours. A phonogram makes it possible for the addresses to hear the voice and the photogram to see the handwriting of the sender, which is important both in business and in private correspondence. The method of facsimile documentation of machine data [4] ensures the possibility of delivering machine information from information storage centers to telephone subscribers. Methods have also been developed for the speech output of machine messages to the telephone network [5].

Thus, an automated system for transmission of written and oral messages via telecommunication channels during the low-load hours of telephone networks can ensure the delivery of photograms, phonograms and machinograms to the addressees without equipping subscribers with special equipment.

The block diagram of the electronic postal service (Figure 1) shows how its system functions. The self-service automatic device 1 installed in communication departments and institutions must be the terminal apparatus open to general use. It must serve for both telephone calls and for the dispatching and receiving of phonograms and photograms. The client dials the "electronic post office" service, reports about the payment for the service, and dials the phone number of the addressee (or his postal index). Then the sender dictates the name of the addressee and the message itself -- the phonogram.

When transmitting a photogram, the sender, after giving the telephone number (or the postal index) of the addressee, inserts into the automatic communication device 1 a standard postcard filled on both sides (the postcard is returned to the sender as a receipt).

In agencies which have UATS [agency automatic telephone exchanges] 2, telephone and facsimile sets 3 are attended by the office personnel.

When transmitting machinograms, the computer 4 calls the "electronic post office" service by sending call signals, gives its code and the number of the addressee, and then delivers a speech or facsimile message to the telephone channel [6].

Any terminal set -- public 1, agency 3 and machine 4 -- relays dialing signals and analog speech or facsimile signals to the ATS [automatic telephone exchange] 5. These signals are recorded in the storage unit 6 in the order of their arrival. The number of the memory zones must not be smaller than the number of the routes, and the recording in the "route storage units" of the ATS must be performed under control of the call signals. Thus, automatic sorting and routing of messages are performed.

During the hours of the lowest load of the ATS, the processing unit 7 directs the message (call number and a mailogram or photogram) to the GTS or the intercity network 8. Calls and messages arrive at the ATS of the receiving point 9. Then the message must be delivered to the agency of the addressee or to the nearest postal department. Since the connecting telephone line may be busy, the ATS must have storage units 10 and processing units 11 analogous to units 6 and 7. Messages arriving at the ATS can be delivered to the postal department, agency, or to the residence of the addressee at the time when he is ready to receive a telephone call or when he calls the "general delivery" service. Phonograms are transmitted from the ATS to the addressee's telephone 12 automatically and are repeated until he hangs up the receiver, or (depending on the category) the subscriber is only informed about the arrival of a phonogram which he can listen to in the postal department.

Accordingly, a photogram can also be transmitted to an agency facsimile set 13 directly from the ATS 9. If the addressee does not have a facsimile set, he is informed about the arrival of a photogram by phone and can receive the message through "general delivery". A message can be delivered to the addressee by a mailman, since the documentation of a photogram or a machine message is done by the facsimile set of the communication department 14. It is also possible to install facsimile receivers in apartment buildings so that the residents of the building would be able to receive their mail themselves, without a mailman.

The variant described above is a "parallel" variant of the system -- with accumulation of messages by the routes (for example, by the number of ATS in the city). A simplified algorithm of this variant is shown in Figure 2. A "successive" variant is also possible, in which case the accumulation of messages takes place without presorting by directions. It is simpler to set up the successive variant, but the parallel variant is more effective in the sense of the utilization of the communications network, because it ensures a minimal number of ATS calls.

Apart from the two variants of decentralized accumulation of messages at the ATS, there exists an alternative variant of centralized accumulation. It is realized in the form of a special message switching centers which ensures the gathering of information from the clients and subscribers during the day (messages are not dispatched at night), and the delivery of messages at night or by request. Centralized storage of messages is connected with additional loading of GTS during the day and, therefore, is not considered here. However, in some instances (for example, when the number of subscribers is small or the load is limited), it is quite realistic to have the variant with a single center for the accumulation and switching messages during the first stage of the creation of the system. Naturally, the final selection of the variant depends on concrete conditions of the designing of the system.

It should be mentioned that it is necessary to have not only stationary storage units of audio signals, but also subscribers' units which could register messages arriving from the communication network. Such storage units could be cassette dictaphones adapted for automatic recording.

Consequently, messages recorded at night can be received on the following day by the subscriber through standard telephones and facsimile sets.

It is simpler to start the introduction of the system with the transmission of phonograms, because this stage is realized without expenditures on terminal equipment and ensures self-service: the sender dictates, and the receiver records the message.

Main Parameters and Sources of System Effectiveness. The main parameters of the system are determined by its daily productivity, i.e., the number of transmitted messages.

In accordance with the schedules of daily loads of ATS in the industrial and residential zones of the city, the transmission time of the system T is 6-7 hours (0-7 AM).

Assuming that T = 6 h, and one mailogram lasts t = 1 min (time sufficient for transmitting a two-sided standard-size postcard, as well as a telephonogram or a machinogram), it is simple to determine the maximum carrying capacity F of the subscriber's communication channel: $F_a = T/t = 360$ mailograms in twenty four hours, which can satisfy the needs of a small communication department, agency, or a residence (subscriber's station).

The maximum volume of the transmission of additional messages in the GTS networks is determined by the potential daily carrying capacity of the network F_{max}, i.e., by the number of simultaneously attended calls X in each of the Z ATS of the network during ChNN [peak-load hours] (let us assume that each ATS has 10,000 subscribers). Consequently, $F_{max} = Z\ X\ T\ t$ messages in twenty four hours. Table 3 shows the values of the maximum carrying capacity in the network depending on the number of ATS, as well as the number of subscribers at a full load of the subscriber's facilities.

The maximum volume of the transmission of additional messages in the intercity networks is determined by the number of intercity communication channels with a reduction of the duty time (to at least one half: $T_M = T/2$) due to the variance of the time zones.

The daily productivity of the system F_c is determined by the product $F_c = FR$, where R is the number of subscribers' stations. The maximum capacity of the subscriber's storage unit is determined by the length of the system's operation in twenty four hours T. This means that for a six-hour continuous recording of analog speech and facsimile signals, it is necessary to have six "hour" cassettes in the storage unit. The station storage units can have the same initial capacity, but the number of cassettes in them is determined by the number of the ATS in the city, and their capacity will be increasing as the system develops. Consequently, subscribers' and station storage units can be standardized on the basis of the cassette dictaphone. With multicassette storage units, it is possible to accomplish successive recording of messages at the ATS and parallel readout during documentation at the subscribers' stations.

The main parameters of the processing unit are determined by the hourly productivity of the system. If the data from a file of M mailograms -- one-minute messages (M = 50) are processed in one hour, then the total message processing traffic makes it possible to select the necessary computing equipment for performing a number of operation on the registration of telephone numbers (postal indexes) of the addressees, sorting of messages by the cassettes of the storage unit, load control at ATS by the routes, delivery of the call and message, acknowlegment of message, etc.

Considering the fact that Z storage units have to be controlled simultaneously (according to the number of ATS in the network), the transmission time of the call signal of minimal length $\tau \leqslant 100$ ms, and the quantization of call signals is done asynchronously, the data input speed of the computer must be not less than $V = \tau/Z\delta$, where δ is the time quantization step (for the case $Z = 10$, $\delta = 100$, and $\tau = 100$ ms, $V = 0.1$ ms). Since the operation speed of modern minicomputers is 2-3 microseconds, the number of calls handled simultaneously can exceed 100.

It should be noted that when speech signals are stored in the digital form, a one-minute message requires a recording volume (controlled the computer) of not less then $Q_o = 25$ kilobytes. When standard computing equipment, such as magnetic tape stores (for example, YeS-1012), with a capacity of $Q = 250$ megabytes is used for recording and reproducing digital signals, it is possible to store 10^4-minute messages in one storage unit. Consequently, one storage unit will make it possible to serve

R subscribers' stations: $R = Q/Q_oT = 30$. Therefore, the variant with digital signal storage proves to be convenient when it is necessary to set up a system rapidly and when the network of subscribers' stations is small -- during the first stage of the introduction of the system. It may be added that in some instances it is not necessary to install subscribers' storage units because subscribers can receive phonograms through "general delivery" from the ATS.

Technical and economic substantiation of the "electronic post office" system must be done in an integrated manner with consideration of the sources of effectiveness existing in various sectors of communications. In the postal service, the growth of capital investments reduces when the network develops, as well as the operating expenses of the existing enterprises due to the decreases in the volume of loads. In telecommunications, the active time of municipal (and then intercity) communications networks increases due to the decrease in the telephone and telegraph loads and the number of repeated calls, which is equivalent to the improvement of the telephone network and the subscribers' teletypewriter network without new expenditures. Finally, the income of the communications industry increases and the quality of services to the clients improves through the introduction of new types of paid communications services.

The effectiveness of the "electronic post office" system can also be evaluated by the increment in the time of paid use of telecommunication networks which increases by $K = T/24 = 25\%$.

The annual economic effect of the "electronic post office" system is determined by the difference between the value of the annual increment of the profit of the communications industry and the value of the expenditures for the system.

Conclusions: 1. The variation of the loads of telecommunication networks during the 24-hour period is an important factor stimulating the development of systems for transmitting simplex messages through telephone networks to postal departments, institutions, and enterprises, and subscribers' stations. The "electronic post office" system can transmit written and oral messages of people and computers (photograms, phonograms, and machinograms) in the form of audio signals relayed during the low-load hours of telephone networks.

2. In order to set up an "electronic post office" system, it is necessary to install computer-controlled storage units at ATS, and to install subscribers' devices permitting the use of standard terminal equipment at the transmission and receiving stations. Devices for magnetic recording of analog signals can be used as storage units. The following must be given for computing the main parameters of the system (productivity, capacity of storage units, type of computer, etc): length of operation of the system during the twenty four hour period, mailogram length, number of the directions of transmission, and the number of subscriber's stations.

3. The economic effectiveness of the system is determined by the increase in the carrying capacity of telephone networks (up to 25%), which makes it possible to improve services to the clients by providing new paid communication services. Moreover, the decrease in the volume of mail items, as well as in the flow of simplex telephone and telegraph messages during the peak hours of GTS will increase the effectiveness and quality in various sectors of the communications industry.

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CSO: 5500/20

USSR

LINE EQUIPMENT OF TRANSMISSION SYSTEM K-1020S

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 81 p 64

[Article by A. I. Pasikova]

[Text] The transmission system K-1020S is intended for increasing the effectiveness of the utilization of main high-frequency balanced communication cables multiplexed with 60-channel equipment to a frequency of 252 kHz, and for organizing large groups of channels in the main and zonal networks. This system makes it possible to organize as many as 1020 audio frequency channels in a frequency band of 312-4636 kHz on one quad of a balanced cable.

The line equipment of the system includes: a line equipment bay SOLT (Figure 1) and an unattended repeater station NUP (Figure 2).

Equipment Specifications

Maximum length of line, km	280
Nominal length of the repeater section when using cables with cores of 1.2 mm in diameter, km	3.2
Permissible deviations of the length of the repeater sections from the nominal value, km:	
without artificial lines	±0.2
with artificial lines	+0.2 -1.4
Line frequencies, kHz:	
line spectrum	312-4636
line pilot frequencies	308 and 4896
remote control signal	76
Operating temperature range, °C:	
SOLT	from +10 to +35
NUP	from -20 to +40

The equipment of the attended repeater stations is fed from a local direct-current power source of 24±2 V with a grounded plus. NUP is fed remotely through a "wire-wire" circuit by a direct current of 100± mA from a source of 24±2.4 V through a converter.

The SOLT bay is installed at terminal and intermediate attended repeater stations and is designed in the form of a functional sectional structure. The overall dimensions of the bay are: 2600 X 680 X 225 mm, its total weight is 300 kg.

The NUP station consists of a hermetically sealed steel casing installed directly in the ground and removable units.

The total saving in capital expenditures on a balanced cable line of 200 km in comparison with the construction of a new line with the same number of channels is 1.4 million rubles.

This system was developed by the Sverdlovsk Branch of the Central Design Office jointly with TsNIIS [Central Scientific Research Institute of Communications].

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CSO: 5500/20

INTERNATIONAL AFFAIRS

FUTURE ARIANE LAUNCHES TO INCLUDE WIDE VARIETY OF SATELLITES

Paris AIR & COSMOS in French 27 Jun 81 pp 57,59

[Article by Pierre Langereux: "Meteosat 2 and Apple: First Satellites Launched by Ariane"]

[Text] The two geostationary satellites successfully launched by the third Ariane rocket are part of the payloads launched under the APEX [Adriane Passenger Experiment] program decided by the ESA [European Space Agency] in 1975. This program led to the selection of five payloads, from among 93 available choices, to be launched free of charge on the last three flight tests of the European launcher. The German scientific satellite Firewheel (1,104 kg) and the German radio amateurs satellite Oscar 9 (92 kg) were lost with the failure of the second launch (L 02). The European maritime telecommunications satellite Marecs A (1,006 kg) will be launched with the fourth and last test shot (L 04) scheduled not earlier than mid-November 1981.

The European meteorological satellite Meteosat 2 (699 kg) and the Indian experimental telecommunications satellite Apple (670 kg) were orbited together with the CAT 3 technological capsule (266 kg) by the third Ariane rocket, which thus carried up a total payload of 1,635 kg. The CAT 3 technological capsule was put into a 200-36,000 km geostationary transfer orbit inclined at 10.5°, while Meteosat 2 and Apple were placed in geostationary orbit at an altitude of 36,000 km.

Apple is the first telecommunications satellite built by India, as the forerunner of the future Insat 1 operational satellites, which are to be built in the United States and launched in 1982-1983. Apple is an experimental satellite designed to test the principal auxiliary and telecommunications equipment components and to enable India to gain experience in the launching and operation of geostationary telecommunications satellites. It is also the first triaxially stabilized geostationary satellite built by the Indian space organization ISRO [expansion unknown]. Designed for an operational life of 2 years, this satellite is equipped mainly with a Band C (466 GHz) telecommunications repeater having an isotropic radiated power of 31.5 dBW, associate with a 9-mm diameter carbon-fiber antenna. Electric power is supplied to the satellite by a solar generator system of two deployable panels, whose initial power output is 280 watts at the start of its operational life, one panel of which, however, appears not to have deployed. The solid-propellant apogee engine was also built by the ISRO. This 325-kg engine, 272 kg of which are solid propellant, is derived from the fourth stage of the new

Indian launcher SLV 3, which has already been used to launch two Indian satellites, one of them only recently. But the latter satellite fell from orbit prematurely as a result of having been placed in too low an orbit by the SLV 3 rocket. Thus, if the Apple satellite cannot be put into service because of the failure of the solar panel to deploy, India faces the loss of two satellites in rapid succession.

Meteosat 2 is the second flight model of the ESA's geostationary meteorological satellites, which represent Europe's contribution to the WWM [World Weather Watch]. The Meteosat 2 satellite is to become operational around 19 July and is to begin transmitting images beginning 28 July.

Placed in geostationary orbit at 0° longitude, Meteosat 2 will observe continuously the clouds and the earth's surface that are visible from the satellite. These data, which are of interest to Europe, the Middle East, and Africa, will be received by the Michelstadt (Germany) station and transmitted to the Meteosat data processing center at Darmstadt (Germany), where the satellite control center is also located. The data will consist of raw images provided every 25 mm by the satellite's radiometer on three wavelengths (visible, thermal infrared and water-vapor infrared). These data, after being preprocessed at the ESOC [European Space Operations Center], are then retransmitted by the satellite to the various users. Owing to the replacement of the Darmstadt Meteosat processing center's computers, however, the Meteosat 2 preprocessed images will not be able to be distributed in the immediate future. Not until March-April 1982 will it be possible to receive Meteosat 2 preprocessed images. There are currently throughout the world around 200 SDUS stations equipped to receive Meteosat images processed to WEFAX standard. Meteosat 2, like Meteosat 1, is also equipped to collect data from automatic platforms situated in the Satellite's zone of visibility.

Meteosat 2 is designed for an operational life of 3 years, but it is hoped that it will remain operational 4-5 years, that is, until mid-1985 or mid-1986. The first Meteosat 1 satellite, which was launched 23 November 1977 and went into trouble 2 years later (end of November 1979) as a result of the failure of a power supply system component (replaced in the second satellite), still had available at the time enough reserve propellant (hydrazine) for attitude control over an additional 18 months.

Looking beyond Meteosat 2, which remains an experimental satellite, it is planned to set up a permanent operational network of European meteorological satellites in geostationary orbit. The system would consist of three or four OPMET operational satellites, which would be launched successively to ensure operation of the network over a period of some 10 years. The first of these is to be launched in 1986 to continue the service that will be being provided by Meteosat 2, operation of which is already being financed by the European weather services, especially by France national weather service.

The decision to install this network of operational meteorological satellites is to be taken by the European nations at a forthcoming meeting scheduled for October-November 1981. The satellites would be operated by a new European organization "Eumestat."

Eight ESA member countries have participated in the financing of the Meteosat program for the building of the first two satellites: Germany, Belgium, Denmark, France, Italy, United Kingdom, Sweden and Switzerland. The satellites were built by industrial consortium Cosmos under the prime contractorship of AEROSPATIALE [National Industrial Aerospace Company] (France) with MATRA [Mechanics, Aviation, Traction and Missiles Company] and SAT [Telecommunications Corporation] (France), Siemens and MBB [Messerschmitt-Baldow-Blohm] (Germany), ETCA [expansion unknown] (Belgium), Marconi (Great Britain) and Selenia (Italy) for the satellite equipment, and with CIR [expansion unknown] (Switzerland), Intertechnique, LCT [Central Telecommunications Laboratory], SESA [expansion unknown] and SLE [expansion unknown] (France), Dornier and Siemens (Germany), Marconi, Plessey and ICL [International Computers (Holdings) Ltd.] (Great Britain) for the ground equipment.

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CSO: 5500/2251

ITALY

RESULTS OF EXPERIMENTAL OPTICAL CABLE SYSTEM COS3/FOSTER

Rome ELETTRONICA E TELECOMMUNICAZIONI in Italian Mar-Apr 81 pp 79-85

[Article by Dr Feliciano Esposto, Engineer Franco Lombardi and Prof Guido Paladin, of the SIP (Italian Telephone Company), Rome: "Results and Evaluations of the COS3/FOSTER Experimental Optical-Fiber Installation"]

[Text] Summary--Results and first evaluations of the optical fiber experimental plant COS3/FOSTER: This paper describes a field experiment with an optical cable connecting different exchanges in the urban area of Rome. The cable route, the structure and the optical characteristics of the cable, evaluated in the factory, are shown. There follows a description of laying procedure, jointing techniques and characterization of the repeater space by instrumentation just developed for this field trial. The results of extensive tests made in the factory and in the field at the different stages are compared and shown. Finally, the results of the system tests at 34 Mbit/s, 850 and 900 nm of wavelength carried out in several months of experiments since July 1979 are presented.

1. Foreword

Studies and experimentation on optical-fiber communications were initiated in Italy in 1970. The first phase was characterized by the building of various kinds of prototype equipment used for transmission of analog signals (TV, etc) and digital signals; in the second phase, a series of experimental installations whose purpose is to evaluate the problems related to introduction of optical cables and systems into the public telecommunications network have been planned.

So far, three experimental installations have been built: COS1 (Experimental Optical Cable 1), COS2, and COS3/FOSTER (Trevi-Eur-Rome South Experimental Optical Fibers), which is in the installation phase.

The COS1 experiment, carried out in 1976 (Bibliography 1, 2), consisted in the laying of 1 km of cable in a trench, under conditions similar to those of an interurban cable.

The purpose of the experiment was to observe the behavior of the optical cable during the installation operations and the stability of the optical and transmission characteristics over time.

The second installation, COS2 (1977) (Bibliography 3), consisted in the laying of 4 km of optical cable between two SIP exchanges (Stampalia and Lucento) of the Turin urban area. Prototype systems of 34, 140 and 560 Mbit/s (Bibliography 4) were tested on cable laid in traditional duct and joined by the springroove technique. The experiment provided knowledge about the laying and splicing procedures.

On the basis of the results obtained by means of the first two experimental cables, it was decided to carry out a new experiment designated COS3/FOSTER, to determine the performance characteristics of the new optical-fiber systems with real traffic and under actual operating conditions.

The main objectives set for the aforesaid experimentation are: characterization of a large number of km of fiber (288 km); development of adequate portable instrumentation; development of accessory exchange equipment (distributor panels, connectors, monofiber wires) and of engineered and alarm-equipped transmission apparatuses for 34 and 140 Mbit/s.

With special reference to this last-named installation, there will be given, in addition to a general description, data relative to the cable-characterization measurements, in the factory and in the field, and the first system-level performance characteristics obtained with simulated traffic.

2. Description of the Installation

The COS3/FOSTER experiment, carried out in joint participation with the ASST [National Telephones State Board], consists in the installation of an optical cable about 16 km long that joins 7 urban and interurban exchanges of the Rome telephone network, per the drawing in Figure 1.

The cable is installed in duct for about 10 km, in galleries for 4 km and in trenches for 2 km; for this last, the cable is protected by an adequate metallic sheathing.

Figure 2 shows the cross-section of the cable developed by the Pirelli industries, containing 18 fibers of 3 different types: 5 fibers (type A) with nominal attenuation of 4 dB/km and band width of 700 MHz X km at 900 nm, and made by the inside process; 9 fibers (type B) with nominal attenuation of 4 dB/km and band width of 700 MHz X km at 820 nm, made by the outside process; and 4 fibers (type C) with nominal attenuation of 8 dB/km and band width of 200 MHz X km at 820 nm.

The fibers are inserted in a narrow tube of plastic material (Ø 2 mm) and twisted in 2 rings (of 8 and 10 fibers) around a central member of steel. In addition to the fibers, the cable contains 4 copper pairs (Ø 0.5 mm, for the service channels), 4 copper conductors (of 0.9 mm, for remote power supply), and 2 bare wires of 0.5 mm for monitoring infiltrations of humidity.

The outside diameter of the cable is 17.5 mm, and its weight is 275 kg/km.

3. Installation and Laying

The installation and laying of the COS3 optical cable were done by the SIRTI [expansion unknown] company, and the knowledge acquired in the preceding experimentations was also made use of. The cable is inserted in an undertube of PE [polyethylene] inside the tube, so as to protect it and at the same time permit use of the tube for the laying of other cables. The undertubes are cut at the entrance to the manholes and fixed to the walls of the tube hole with expansion flanges. In the manholes and in the passageways with access, the cable is protected with iron conduit and with cable-cover sleeves of zinc-plated sheet.

For the laying in pipe, an electric winch was used that permits continuous recording of the pulling force in function of the length of cable being laid. A typical graph is shown in Figure 3. The maximum pull recorded for a length of 884 m was 140 kg.

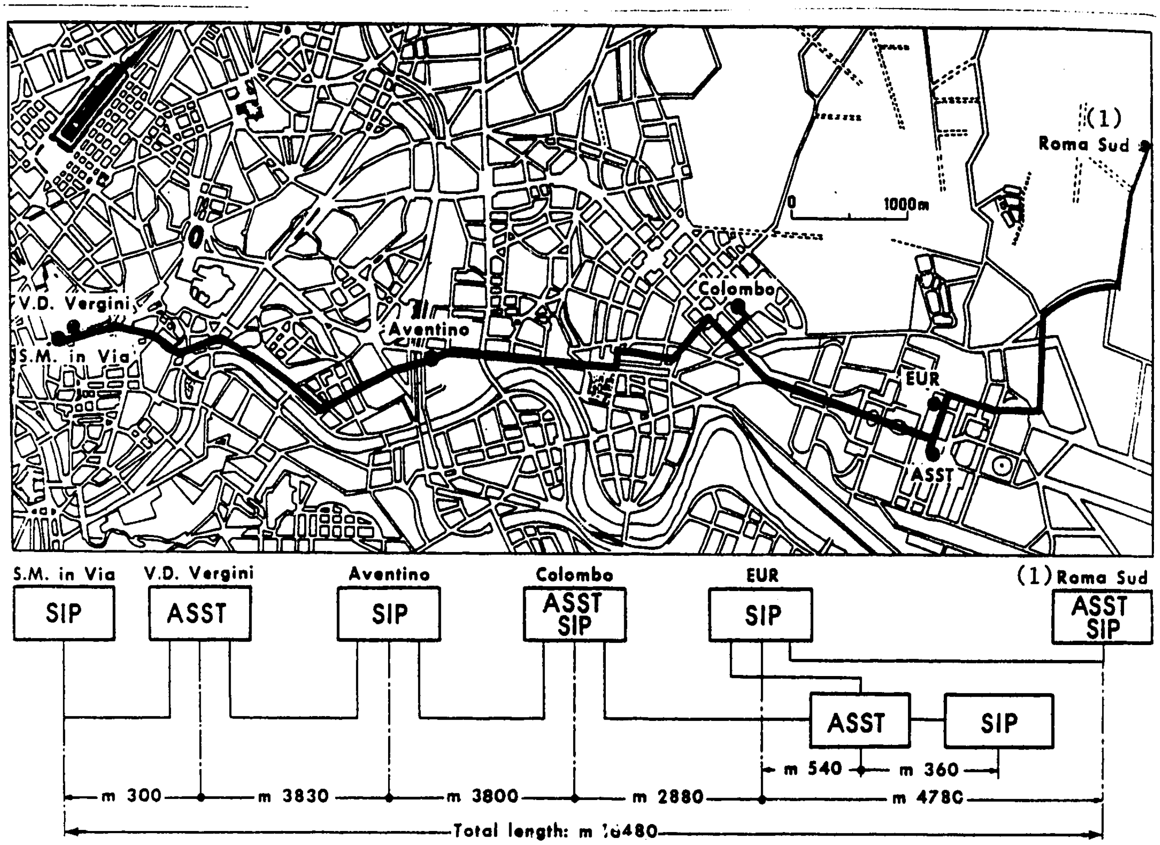

Figure 1.- Run of the COS3/FOSTER Installation and Sites of the Exchanges Connected

Key: 1. Rome South

4. Characterization of Cable in Factory and in Field

4.1 Measurements in Factory

For characterization of the transmission medium both in the factory and in the field, a series of measurements was made relating to various aspects such as evaluation of the optical and mechanical characteristics of the fibers and their variation during the various phases of production.

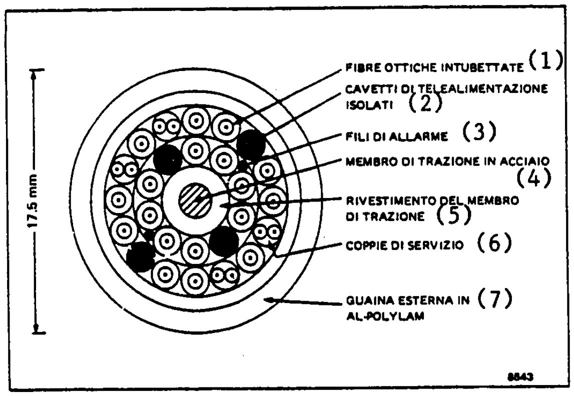

Figure 2 - Cross-section of Pirelli cable containing 18 optical fibers

Key:
1. Optical fibers enclosed in tubing
2. Insulated remote-power-supply wires
3. Alarm wires
4. Pulling element, of steel
5. Covering of pulling element
6. Service pairs
7. External sheathing of AL-Polylam

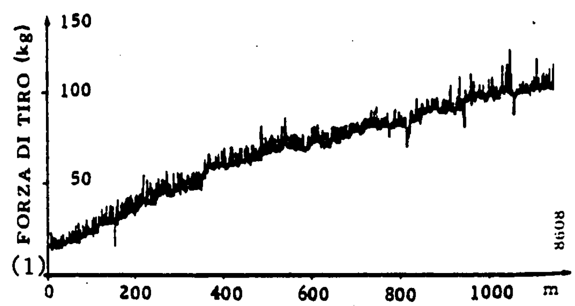

Figure 3 - Diagram of pulling of the NF3 cable segment

Key: 1. Pulling force (kg)

Table 1 - Geometric Characteristics of the Fibers

	Diameter of core (μm)		Diameter of cover (μm)		Ellipticity of core (%)		Concentricity (core/cover)	
	A	B,C	A	B,C	A	B,C	A	B,C
Average value	63.9	64	126	2	0.7	0.5	0.5	0.5
Standard deviation	2.8	2.4	2.9	2.7	--	--	--	--
Average value	71	69	133	132	5	2	2	2
Standard deviation	57	57	120	120	0	0	0	0

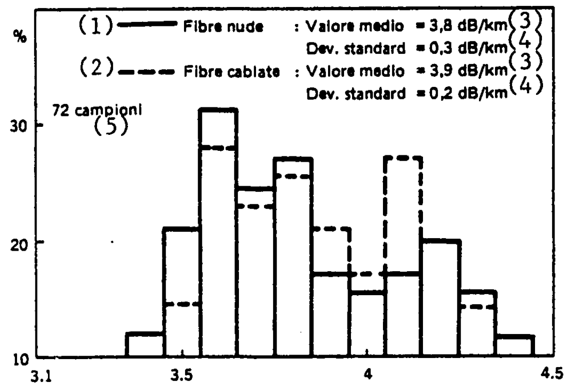

Figure 4 - Distribution of attenuation values before and after cabling of several fibers used in the cable for the COS3 installation

Key:

1. Bare fibers
2. Cabled fibers
3. Average value
4. Standard deviation
5. 72 samples

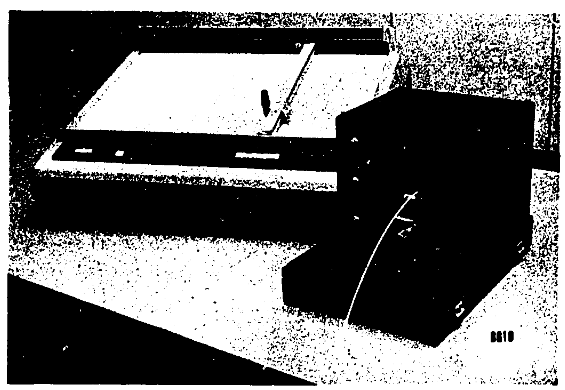

Figure 5 - View of back-scattering apparatus used in field for measurements of optical-fiber attenuation

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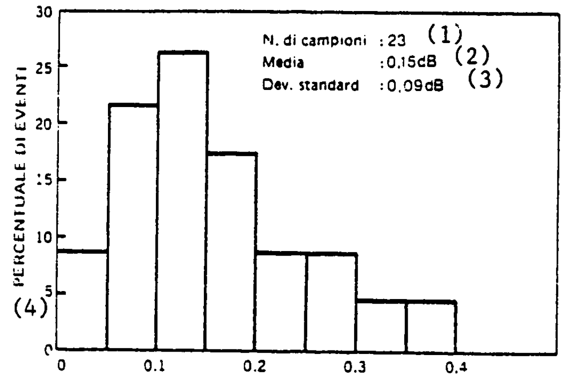
In the factory, attenuation and band measurements and measurements to check the geometric characteristics of the fibers were carried out. By way of example, Figure 4 presents a histogram that gives the attenuation value for 72 samples of fiber used in the two manufacturing phases: fiber enclosed in tubing and cabled fibre. It appears obvious that the process of making up the cable does not considerably alter the aforesaid characteristics. As regards geometric characterization, dimensional measurements were done on several of the fibers used: diameters of core and of cover, circularity and concentricity defects.

Table 1 presents the results of the measurements made, which show a certain deviation from the nominal values (62.5 μm and 125 μm, respectively, for the core and cover diameters), while the concentricity defects prove sufficiently limited.



ATTENUATION OF JOINTS (dB)

Figure 6 - Distribution of losses in joints made in the field and measured by the back-scattering technique

Key:
1. Number of samples
2. Average
3. Standard deviation
4. Percentage of events

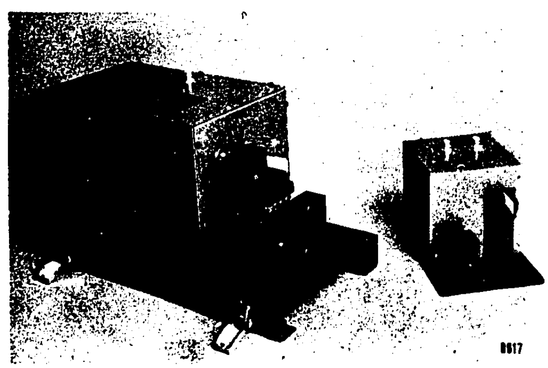


Figure 7 - Transmitter unit (at left) and receiver (at right) of the instrument for attenuation measurements in the field

Table 2 - Comparison between values measured in factory (predicted) and in the field

Number of fibers	Values measured in field a_1	Values measured in factory a_2	Difference $a_1 - a_2$
1	9.92	9.64	+0.28
3	28.23	27.37	+0.86
5	13.75	13.33	+0.42
12	21.48	19.78	+1.7
14	13.88	13.31	+0.57

All the values are expressed in dB

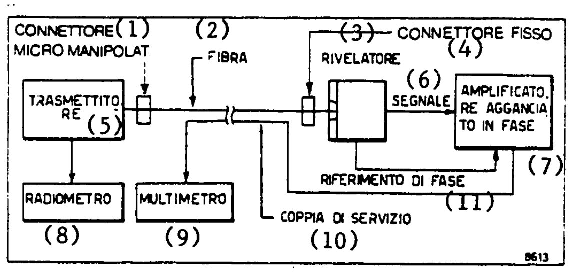
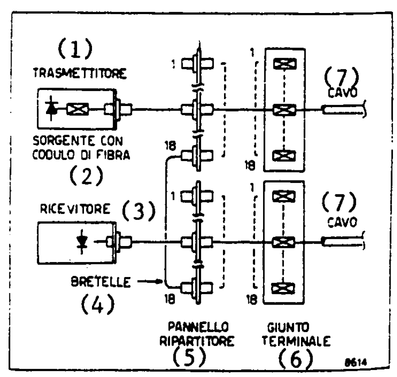


Figure 8 - Block diagram of the instrument illustrated in Figure 7

Key:

1. Micromanipulator connector
2. Fiber
3. Detector
4. Fixed connector
5. Transmitter
6. Signal
7. Amplifier, connected in phase
8. Radiometer
9. Multimeter
10. Service pair
11. Phase reference

Figure 9 - Diagram of exchange-terminal connections



Key:

1. Transmitter
2. Source with fiber tang-end
3. Receiver
4. Crossovers
5. Distribution panel
6. Terminal connection
7. Cable

Measurements were also made of the transmission characteristics of the fibers in tubing in function temperature in the field, -40 to +60 °C, without the appearance of significant variations of the attenuation constant or the band.

4.2 Measurements in Field

During installation of the cable, measurements were made of the attenuation constant of several segments and of the sections of cable between adjacent exchanges, and checks were also made in the joining phase.

The 18 fibers of the cable of the first sections were measured before and after the laying by use of the back-scattering technique. The apparatus used, developed at the CSELT [Telecommunications Research and Study Center] laboratories (Bibliography

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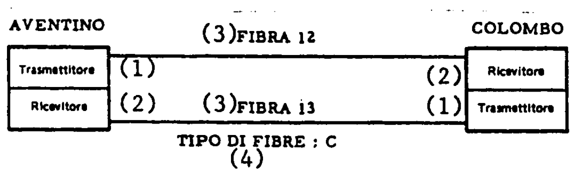


(5) LUNGHEZZA	m	3800
Attenuazione misurata (inclusi i giunti) (6)	dB (3)	fibra 12, 22.6 fibra 13, 23.7
Larghezza di banda dovuta alla dispersione modale (7)	MHz · km	200

Figure 10 - Characteristics of connection functioning at λ = 850 nm

Key:
1. Transmitter
2. Receiver
3. Fiber
4. Fiber type: C
5. Length
6. Attenuation measured (including joints)
7. Band width due to modal dispersion

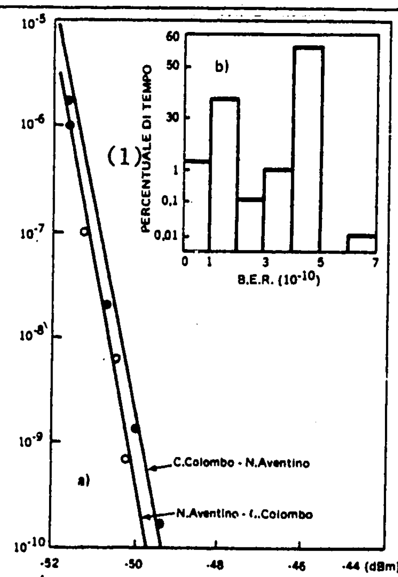


Figure 11 - a) Error rate (B.E.R. = Bit Error Rate) in factory for Italtel equipment of 34 Mbit/s. b) Statistical distribution of B.E.R. from July 1979

Key:
1. Percentage of time

5) and shown in Figure 5, has a measurement dynamic of about 12 dB and a repeatability of $\pm$ 0.05 dB.

In the two abovementioned phases of laying, no changes in optical characteristics were detected. The apparatus was also used to monitor the joining operation in the

Table 3 - Balance-Sheet of Optical Powers for the 847-nm System

Source BNR 40-3.15.3		Aventino Colombo	Colombo Aventino
		λ = 847 nm $\Delta\lambda$ = 54 nm	λ = 851 nm $\Delta\lambda$ = 53 nm
Power transmitted	dBm	- 13.9	- 15.4
Power received	dBm	- 40.6	- 43.6
Attenuation of cable	dB	22.6	23.7
Loss from connectors and contributions from leaky beams	dB	4.1	4.5
Penalties from material dispersion	dB	4.5	4.0
System margin	dB	4.8	2.5
Sensitivity of receiver (with dispersion)	dBm	- 45.4	- 46.1
Sensitivity of receiver (without dispersion)	dBm	- 49.9	- 50.1

Table 4 - Balance-Sheet of Optical Powers for the 900-nm System

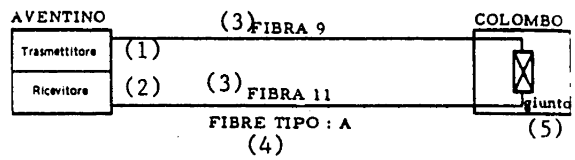
LED SGS-ATES		λ = 896 nm $\Delta\lambda$ = 36.5 nm
Power transmitted	dBm	- 14.6
Power received	dBm	- 39.4
Attenuation of cable	dB	20.7
Losses from connectors	dB	4.1
Penalties from material dispersion	dB	5
System margin	dB	5.2
Sensitivity of receiver (with dispersion)	dBm	- 44.6

execution phase. and for evaluation of the joint losses by use of the bidirectional-measurement procedure (Bibliography 6). The joint-loss results obtained for the COS3 installation are presented in Figure 6.

For measurement of the attenuation of the sections, which are 4 km long on the average and have attenuations of 10 to 30 dB, depending on the fiber type used, a special instrument for field use was developed in the CSELT with the collaboration of the SIP.

This instrument, which functions on the "insertion loss" principle, makes it possible to take nondestructive measurements and to operate in conditions very similar to stationary-state, with the power in the fibers under measurement determined by the "small-diameter small-numerical-aperture spot" method.

The abovementioned apparatus has a high measurement dynamic ($\simeq$ 45 dB) and makes it possible to couple a power in the various fibers of the cable with an error of $\pm$ 0.14 dB.



LUNGHEZZA (6)	m	7800
Attenuazione misurata (giunti inclusi) (7)	dB	20.7
Larghezza di banda dovuta a dispersione modale (8)	MHz · km	700

Figure 12 - Characteristics of connection functioning at λ = 900 nm

Key:

1. Transmitter
2. Receiver
3. Fiber
4. Fiber Type: A
5. Joint
6. Length
7. Attenuation measured (including joints)
8. Band width due to modal dispersion

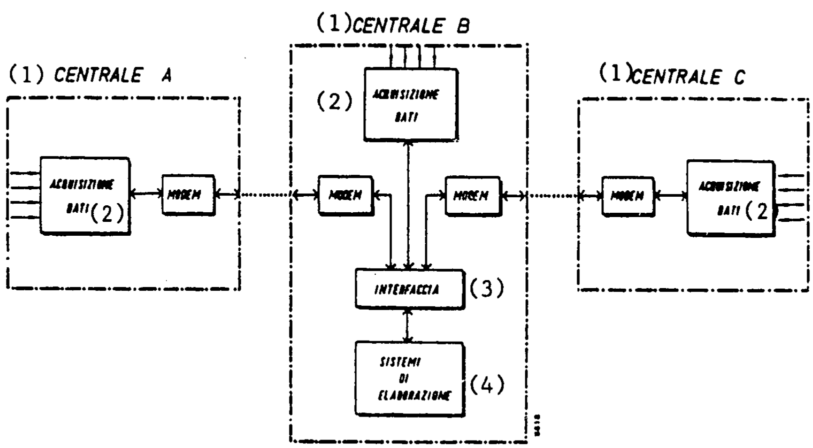


Figure 13 - Acquisition and Processing System

Key:

1. Exchange
2. Data acquisition
3. Interface
4. Processing systems

In Figure 7 can be seen the two units, transmitter and receiver, used in the experiment, while Figure 8 presents the basic diagram of the apparatus.

A comparison between the values measured individually on the 1-km segments in the factory (by an analogous technique) and those obtained in the field is given in Table 2. The values are in reference to six optical lines of the cable of the Santa Maria in Via-Aventino section.

The values show a limited difference between the predicted values and the values measured in the field.

The fact that these differences are modest ones is due to various factors, among which we should mention the uniformity of the measurement methods employed in the factory testing facilities and of the portable field instruments and the good repeatability of the measurements made under differing operating conditions.

5. Termination

In the exchanges, the cable will be terminated with Western Electric connectors per the diagram of Figure 9 (Bibliography 7).

The pot-head connection in which the cable terminates and from which issue the monofiber wires ending in connectors is contained in the same distributor box from which issues a crossover that goes to the semiconnector on the equipment frame.

6. System Tests and First Experimental Results

Since July 1979, two 34-Mbit/s transmission systems functioning with simulated traffice through a pseudorandom data sequence have been installed. The two terminals have been built by Italtel and use different LED's with wavelengths of 850 and 900 nm, respectively.

The measurements on the two systems were made by the use of two bidirectional line terminals functioning on two different types of fiber (A, C).

The receiver in particular uses, as photodetector, an APD diode, RCA C30817, connected to a transimpedance amplifier. Figure 11 a) shows the course of the error rate (BER = Bit Error Rate) in function of the optical power received through the two receivers used on the line (Bibliography 6, 9, 10, 11, 12).

The sensitivity, for an error rate of 10^{-9}, using the differential code and not considering the dispersion, is -50 dBm. Table 3 presents the principal characteristics of the system with the margin available.

The error rate was recorded coninuously on the Colombo-Aventino section during the first 6 months through the addition of a flat attenuation in transmission of about 2.5 dB in order to increase the error rate and make it measurable at a value around 10^{-9}.

One notes from the histogram of Figure 11 b) that for 60 percent of the observation period (6 months), the connection's performance was at a value higher than 5×10^{-10} of error rate (the nominal value of the systems). These performance characteristics, even if related to a limited time-period, prove higher than those of analogous systems using traditional copper equipment, in which there are phenomena of atmospheric disturbances and electromagnetic inductions that cause a deterioration of the system's performance characteristics and at times even interruption of service. Indeed, as regards the interruptions of simulated traffic for the period of observation, the following results can be stated in summary:

--there were no interruptions due to breakdowns of optical components (LED, APD);

--there were no interruptions due to breakdowns of electrical components.

To conclude, in this time-period the optical components enclosed in cable produced operatio . performance characteristics with good reliability. We should nevertheless stress the fact that for the time being, data are not available regarding the operational use and maintenance of these new carriers.

The measurements on the system functioning at a wavelength of 900 nm were made by connecting the 9 and 11 fibers of the cable in the C. Colombo exchange. These fibers present, at 900 nm, an attenuation that is about half that of the fibers used in the preceding experiment. The transmission of a 34-Mbit/s signal is in fact being tested with such fibers on the 8-km Aventino-Colombo-Aventino section with the use of line terminals similar to the preceding ones but operating at a wavelength of 900 nm, at which level the dispersion of material is reduced.

The characteristics of the connection are presented in Figure 12, while the balance-sheet for the optical powers involved is given in Table 4.

7. Data Acquisition and Processing System

The acquisition system provides for observation of a maximum number of 8 transmission systems operating at speeds of 8, 34 and 140 Mbit/s for each exchange and for a maximum number of 5 observed exchanges.

The system is made up of five peripheral devices, one per exchange, and a computer located in the observation exchange, per the diagram of Figure 13.

The central computer is interfaced with suitable peripheral units (for visualization of the data) and to processing units (microprocessors) in the various exchanges, from which the magnitudes observed can also be noted.

Several magnitudes were identified that it was considered advisable to keep under observation for characterization of the system's performance. In particular, the value of the control current of the LED and the temperature of its container are monitored in the transmitting terminal, while the current in the reaction ring of the automatic gain control, the polarization voltage of the APD, and the error rate are monitored at the receiving terminal.

In addition, the alarms of the transmission apparatuses are monitored.

The data resulting from such acquisition will give useful information about the parameters to be monitored in future standardized equipment and for managing the new transmission systems at the operational and maintenance levels.

8. Conclusions

The COS1, COS2 and COS3/FOSTER experiments have made it possible to acquire considerable experience in the operations of laying cable in different conditions (in duct, gallery, trench), in the techniques of connecting and in the perfecting of procedures for characterization of the transmission medium, both in the factory and in the field, with the development of appropriate portable instrumentation.

In the course of this experimentation, cable sections have been drawn through pipe to lengths of 1 km without any substantial variations of the optical characteristics noted. The first 34-Mbit/s system, functioning at 850 nm, was installed, with its performance characteristics verified, on low-cost fibers with a regeneration pitch of about 4 km, a pitch that makes it possible to cover about 85 percent of the connections between the adjacent exchanges in the urban area of the telephone network. A second system functioning at 900 nm on good-quality fibers have made it possible to reach regeneration pitches of about 8 km, which is an attractive distance for use on the district level with a minimum number of intermediate regenerators sited possibly in intermediate exchanges.

On the basis of the results obtained during the first experimental period, begun in June 1979, first use of the Rome cable with real traffic was started in November 1980.

The experience acquired with the building and experimental operation of COS3/FOSTER is the background that makes it possible to plan the imminent construction (starting in 1982) of optical-fiber installations that can be operated in each of the SIP's five zones as replacements for metal cable.

Such installations will be done in both urban and district areas with mixed laying (gallery, duct, trench).

The characteristics of the cables and the equipment and the procedures for approval-testing of them are presently being standardized. In addition, the portable field instrumentation necessary both in installation and in operation has been developed and used (already on COS3/FOSTER). It is also planned to build installations designed for experimentation with new laying systems and new technologies, the characteristics of which can be summarized as follows:

--COS4: laying of a cable on poles in a sector area;

--COS5: installation optimized for use of 2nd-window systems in distric and inter-district areas.

Experimentation with transmission of several optical signals of different wavelengths on a single fiber (WDM: Wavelength-Division Multiplexing) is also planned.

However, the fact of having acquired with COS3/FOSTER systematic experience that makes it possible to build operable fiber installations with LED source in the 1st window (900 nm) at 34 Mbit/s--installations that are already competitive with those using microcoaxial cables--should not make one forget the fact that the fiber systems are continually evolving (for example, passage from LED to LASER and from the 1st to the 2nd optical window), and that in the more distant future it will be possible to build them with performance characteristics far superior to the present ones (especially as regards the length of the sections).

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